WWW based Simulation Systems and Project Platforms in Civil Engineering

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1.Introdcution

1.1 Main Tasks in Civil Engineering

Civil engineering deals mainly with the design, construction and operation of artificial infrastructure in the natural environment to satisfy the related needs of the society under economical and ecological conditions. Important engineering tasks (besides others) for these challenges of modern engineering can be classified as:

- modelling and simulation tasks
- design and construction tasks
- operation, control and management tasks
- documentation and collaboration tasks

The analysis of the infrastructure with respect to its structural, physical and functional behaviour and its interaction with the natural environment requires the modelling and the simulation of the related part of the real world. The human artificial infrastructure has to be designed and constructed. The use of the infrastructure requires operation, control and management for its entire live period. Civil engineering projects are complex projects demanding for a heterogeneous and interdisciplinary collaboration of experts from different disciplines to consider all relevant topics. These experts and their organisational entities are operating in competition on the world wide global market of engineering business. They form virtual organisations for the specific engineering projects. The collaboration in these temporal entities is performed by predefined interfaces and roles, is based on documentation and communication and has to be supported by suitable software systems.

Software systems in civil engineering are traditionally designed and applied for given tasks to a single engineer running on a single desktop computer. Network application is mostly reduced on file based data transfer. Well known examples are simulation systems based on numerical (e.g. finite element method) or artificial intelligence (e.g. neural networks, fuzzy logic) methods, CAD system for design and construction and word processing systems for documentation. The interdisciplinary collaboration of several experts from different (international) locations with time shifted working time in complex civil engineering projects is poorly supported by the available software system. The traditional working processes and methods in civil engineering shaped over decades based on the available technology and reflected in the habits and behaviour of engineers who do not consider the partial overcoming of time and space by the Internet and the WWW at the moment.

1.2 Technological Evolution

It is a hypotheses that the Internet and the WWW started a technological evolution (’Kondratieff cycles’) comparable to those of the industrial revolution (steam engine 1769), the mobility revolution (locomotive 1825/1830, automobile 1885), the chemical revolution (organic chemistry 1828) or the electronic revolution (electronic telegraph 1847, electric light 1879, transistor 1947). It can be observed that the Internet and the WWW dramatically changes wide areas of daily live and business in the society. Examples for this ongoing process are new keywords like e-business and e-commerce as well as virtual universities and distance learning tools for continuous education. Under this hypothesis civil engineering will (or already is) be subject of deep changes.

1.3 Changes in Civil Engineering

The beneficial utilisation of modern information- and communication technology (ICT) in civil engineering projects is more difficulty than in other disciplines. Main reason is the high level of heterogeneity and interdisciplinarity of the involved experts, the fact that built infrastructures in their specific natural environment are unique as well as the high number of uncertainties and unforeseen events in the different phases of project realisation. One key question in civil engineering at the moment is the beneficial and effective adaptation and application of available Internet and WWW technology to the special needs in civil engineering.

The tasks of civil engineering are driven by the needs and demands of society for new infrastructure in the natural environment not realizing the available techniques from ICT. These determine and deeply influence the applied methods, processes, models and systems of engineering. It is believed, that the fast evolution/revolution in ICT in the past decade and in the near future leads to deep changes in all parts of the society and of course in civil engineering. Methods, processes, models and systems in civil engineering have to be adapted to these changes and will (and have already) deeply influence practise, research and education. New methods, processes, models and systems have to be developed and introduced to extend the existing one. They are based on the same theoretical background (e.g. mathematics, physics, social science) as the existing one. There is no new theoretical basis, but their focus will be moved or will be extended. For example besides analytic and numerical mathematics other topics like the set theory are ‘recovered’ in their relevance for civil engineering practices. This leads to new concepts and ways of engineering and hopefully to new beneficial solutions for the demanding tasks of civil engineering.

The authors see a big gap between the state of the art in civil engineering and the potential of ICT for modern engineering esp. in the topic education, which normally should be the background of research and practise. It is a huge challenge for all parts of civil engineering to close this gap, which will need mayor efforts in research, (continuos) education, development and application. The Institut für Bauinformatik at the BTU Cottbus tries to contribute to this challenge by several activities in international education and research projects. Some examples of WWW based simulation systems and project platforms are sketched in this paper, a more detailed description is out of the range of just six pages. But the IKM conference will hopefully provide the platform for some detailed practical demonstration as well as further discussion and exchange of ideas.

2. WWW based Simulation Systems

Simulation systems are used in civil engineering to forecast the physical and structural behaviour of artificial infrastructure in the natural environment. They are often based on numerical methods (like FEM, FDM) and applied in the different branches of civil and environmental engineering such as structural engineering and water engineering. Independent from the different application fields and used software technologies these systems are composed in general by six types of components:

- model information base
- model processor
- model editor
- model analysis
- model reporter
- model manager

The model information base contains all necessary information represented by data. The model processor contains the algorithms for the simulation of the physical. Core of model processors are mostly finite difference or finite element applications but also analytic solutions and assumptions.

The model editor is the user interface and contains suitable instruments to present and edit the data in the information base. The model analysis contains the necessary data analysis functionality for pre- and post-processing independent from the model processor. The model reporter supports the engineer to document its activities esp. the modelling process and the resulting conclusions and decisions. The model manager is the interface between information base and the other components.

In conventional software systems these six components are inter-depending software modules, integrated in one system using internal or standard data interfaces and running on a local computer. Sometimes the user interface is separated by its own as pre- and post-processing tool and the data base is implemented by a commercial data base product with client/server structure. But in principle it is not possible to isolate the different components of traditional systems for a flexible distribution in the net. WWW based software systems are conceptually independent components implemented as complex WWW objects. Using this principle a project engineer as end user is more flexible to composite a specific simulation system for his specific project by plug selected components over and in the Internet together. The exchange of information between these components over the Internet is realised by the transfer of platform independent objects and communication protocols.

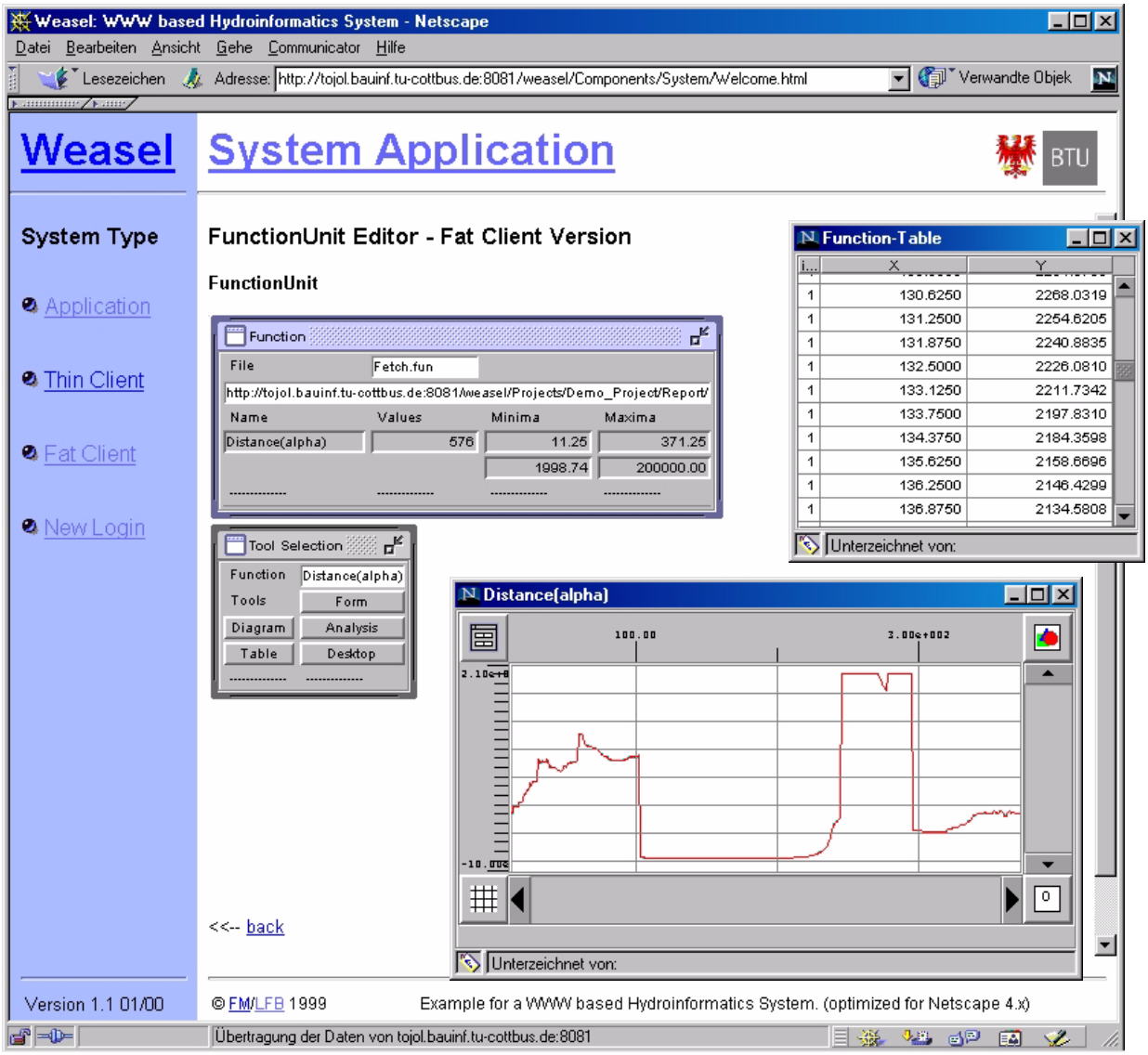

Figure 1. Example from Weasel: Fetch Function Editor as Fat Client Version

Based on this approach a prototype of a WWW based simulation system in coastal engineering called WEASEL has been developed and applied in projects. Application field of the system is the modelling of the coastline stability by a longshore one dimensional sediment transport simulation. Weasel has been installed in the WWW and can be used by everybody from everywhere at everytime - one of the advantages of the Internet. This approach can be easily transformed to other fields in civil engineering such as structural engineering. Details of this new software approach and the related changes in the working process in engineering are described in [2] and [5]. A demonstration of the software will be given during the IKM.

3. WWW based Project Platform

WWW based project platforms are the base of modern collaborative engineering in distributed, heterogeneous and interdisciplinary engineering projects. They allow a new kind of information handling and working processes in engineering to partially overcome the time and space distribution on a global engineering market. The design and development of such WWW based project platform is still a topic of research in civil engineering than in branches with more standardised tasks like finance business and automobile industry. Some examples for approaches in research and education projects are given below.

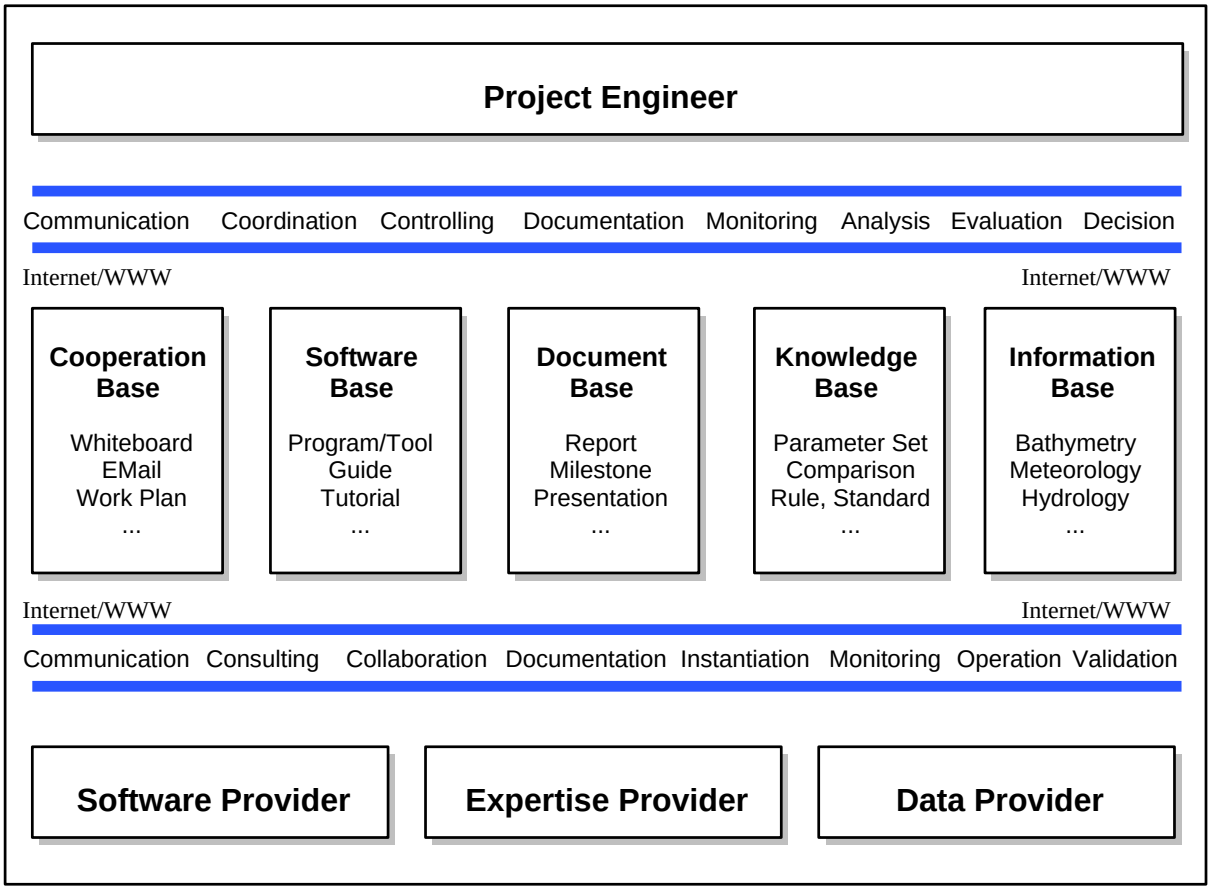

Figure 2. General Concept of Project Platform in MorWin

3.1 Example Project MorWin

MorWin is a hydroengineering research project [1]. Targets of this project are modeling of the morphodynamic processes at the German coast of the Baltic Sea near the Island of Rügen and the test implementation and application of an Internet based project platform to support the working process in a 'Virtual Institute'.

The working process inside the 'Virtual Institute' is based on a distributed net based project platform. The project group is composed by software provider (numerical simulation), by expertise provider (physical modeling), by data provider (water administration offices) and the project engineers running the project. The concept of the project platform is presented in Figure 2. Details of the concept of the ‘virtual institute’ and the WWW based project platform is described in[1] and will be demonstrated on the IKM conference.

3.2 Example Project TaiGer

The project TaiGer [3] is a joint Taiwanese - German research project on WWW based collaboration in coastal engineering. The project deals with the development and application of a WWW based collaboration environment for distributed coastal engineering projects with focus on the integrated analysis, visualisation and documentation for two-dimensional hydro- and morphodynamical simulation. Based on the application of interactive dynamic WWW documents, 3D virtual worlds and GIS applications as well as corresponding conferencing tools and shared working spaces, this new kind of engineering platform enables scientist and engineers from Taiwan, Germany and other countries all over the world for close co-operation via Internet in common coastal engineering projects. The user becomes independent from their local computer facilities. The Internet becomes the computer, the WWW the operation system. Both is available all over the world. This will open a new way of transcontinental collaborative engineering. The platform will be demonstrated on the IKM conference.

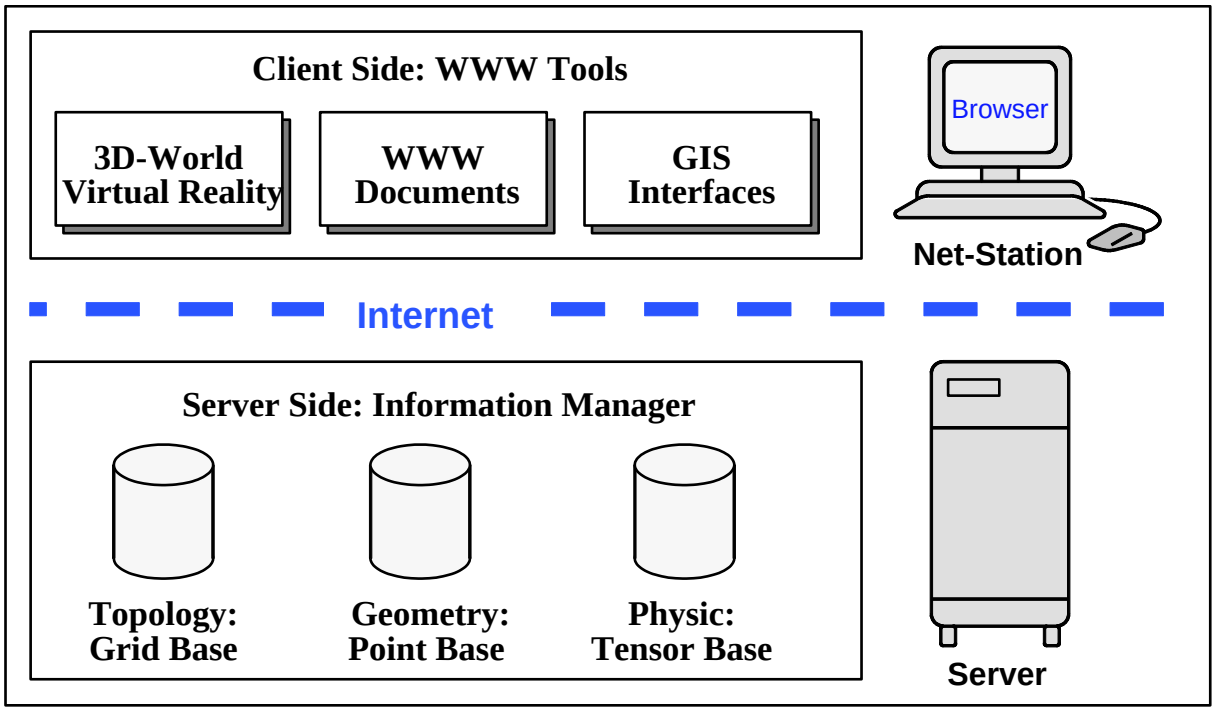

Figure 3. General Concept of TaiGer

3.3 Example from an European Education Experiment

The course 'WWW based Collaborative Engineering in Hydroscience' [4] is a joint education experiment of five European universities. Target of the course is the introduction of collaborative engineering in the academic education programs to prepare students for their future professional live. The idea of this course is simple: Students from different locations get a task from civil engineering which has to be solved in a defined duration in small distributed teams using WWW based telecooperation tools. 'Playing' in a distributed project environment will hopefully lead to knowledge, experience and competence in WWW based collaborative engineering in an international, interdisciplinary and multi-culture environment.

Working in the WWW and net based collaboration on projects with colleagues from other disciplines and nationalities is not only a theoretical matter and a question of application. Key point is the acquisition of experience and the development of a 'Technical Culture' in the society as 'Competence for Tomorrow'. This can be achieved only by practical experiments and exercises. This education experiment tries to give both, students and lecturers from different universities the chance for acquisition of experience in this field to be better prepared for future challenges.

4. Conclusion

The availability of the WWW technology and the introduction of the Internet as basic resource like water, electricity or gas changes dramatically normal live, business and of course engineering. New technologies enable innovative technical solutions and offer new potential for improvements towards support of humans nature appropriate ways of working. This demands a new culture of work and collaboration. To contribute to theses challenges is a matter the discipline ‘Bauinformatik’ by supporting related research, development, education and training in civil engineering.

4. References

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